SOVIET SCIENTIFIC TECHNICAL MANPOWER

1. INTRODUCTION

The Soviets have consistently regarded science and technology as the key to the attainment of their national economic and military goals. The organization of the government at the highest levels has been directed at supporting their scientific and technical objectives. Three key organizations - the Academy of Sciences, the Ministry of Higher Education, and the Gosplan - all report directly to the Council of Ministers and by virtue of their authority in this centralized governmental structure the Soviet leaders have been able to plan and to enforce nation-wide programs for scientific and technical education which provide for mobilization of all available material and human resources. As a result, the USSR has trained and is now training a large body of scientists and technicians which is increasing in size and in quality, and which warrants comparison with that possessed by the United States.

2. THE GENERAL QUALITY OF SOVIET SCIENTIFIC-TECHNICAL MANPOWER

The quality of Soviet scientific-technical manpower is uneven because of past variations in the quality of its training and experience. The Soviet Union inherited from pre-revolutionary times a nucleus of competent scientists and skilled workers but they lacked experience in the application of science to production. Soviet leaders early set the goal of a scientific-technical effort adequate for the support and development of their economy. But the first decade and a half of the Soviet period saw a general decline in the quality of Soviet science research and higher education. By the early thirties, after the

particularly rapid expansion during the first five-year plan, standards of performance in research and education had fallen to low levels. Soviet science and technology remained weak and the plants and production techniques which were established in the early and mid thirties were largely direct importations. About 1933, confronted with the futility of over-rapid expansion, Soviet leaders checked the rates of growth of numbers of students to enforce higher standards of quality. In higher educational institutions, courses were extended and discipline was strengthened. Systems of examinations and advanced degrees were set up and science workers and instructors had to meet new requirements. Such measures, together with concurrently growing mastery of imported technology and increasing supplies of better prepared graduates from secondary schools, have resulted in improving standards of scientific research and higher education.

The Soviet Union continued to train scientists through World War II, though not at the level previously attained. Subsequent to World War II, with the realization of the contribution that science and technology had made to the strength of the West during the war, the Soviets greatly increased their effort to improve their own science and technology.

The force of the Soviet program of higher education for science is shown by the numbers of institutions and students engaged in it. Since the Revolution, the numbers of Soviet higher educational institutions and their students, in all fields, have multiplied by about ten times, from 91 institutions with 112,000 students in 1918 to about 900 institutions with 1,100,000 full-time and 400,000 extension-course students at present. There have been comparable increases in scientific and technical fields.

institutions have completed about fifteen years of intensive study with a generally far greater and more consistent emphasis on scientific subjects in secondary schools than is found in the United States. Careers in science and engineering in the Soviet Union are made especially desirable by the inducements of high salaries and social prestige, and attract the best students. Recent Soviet efforts in many fields, both in theory and in application, demonstrate a high degree of competence.

3. QUANTITATIVE MEASURES

a. General

In the Soviet Union, as in the United States, scientific advance and its applications depend upon the participation of persons with widely varied capabilities. The varied nature of this participation and the frequent absence of clear boundaries between applied science and production engineering make such a term as "Soviet scientific-technical manpower" very difficult to define. But it is possible to select certain comparatively well defined groups which are engaged either in scientific research and development or in related activities and which provide a fairly sound basis of comparison.

b. Groups and Categories

The quantitative measures of Soviet and American scientific-technical manpower which are used here compare numbers of

persons in mid 1953 on several bases. These are; graduates of higher educational institutions and holders of advanced degrees - The Soviet Kandidat and the American Ph.D. - in scientific and technical fields. These fields are grouped into the categories physical sciences, agricultural sciences, and heal;th sciences. They are most convenient because they are the categories regularly used in Soviet literature. The scientific and technical fields contained in these categories are the following:

(1) Physical Sciences

Physics
Chemistry
Mathematics
Metallurgy
Engineering (aeronautical, chemical, civil, electrical, mechanical, etc.)
Astronomy
Meteorology
Geology and Geography
Other fields based on Physics, Chemistry, or the Earth Sciences

(2) Agricultural Sciences

Agriculture (Agronomy, Animal Husbandry, Forestry, Entomology, etc.)
Biological sciences, other than those included under "Health Sciences."

(3) Health Sciences

Medicine and Medical Sciences
Dentistry and Dental Sciences
Other fields supporting health and sanitation (excluding nursing unless based on 4-year curricula)
Biological Sciences, other than those included under "Agricultural Sciences."

c. Comparisons

(1) The total living graduates of higher educational institutions (colleges and universities) actually employed within the two countries in scientific and technical fields is compared on Chart 1.

This chart indicates that Soviet scientific-technical manpower resources compares in size with that of the United States and also that the relative proportions of persons in the major groups in each country are not dissimilar.

(2) Soviet higher education lays a much heavier stress on science than is found in the United States. Over the past twenty years the proportion of Soviet graduates in scientific fields has varied from around 70% to 44%, the current figure. Many of the Soviet graduates excluded from these percentages have been trained to teach science in the expanding secondary school program. During the same period in the United States the percentage of graduates in scientific fields has held close to 30%. Chart 2 compares the number of graduates in scientific and technical fields with the total graduates in 1953 on a percentage basis.

(3) Chart 3 compares the annual numbers of persons graduating in scientific and technical fields in the U.S.S.R. and in the United States. The drop in Soviet graduates in 1933 followed a lengthening of courses of study, and the rapid rise in 1935 and after was in consequence of expanded enrollments

from 1930-1932. Both Soviet and the United States curves show war time losses and rapid post-war increases which, in the United States, under the action of the "GI Bill" reached a peak in 1950. Since that time graduation trends have favored the Soviet Union.

The data for the curves in the preceding charts showing Soviet graduates are fairly complete through 1945 and after this date are partly interpolated and extrapolated. Assumptions, based on scattered data, had to be made on the numbers graduating in the three subject categories from the Universities (as opposed to the more numerous specialized colleges) where no breakdowns are obtainable. The predictions of future numbers of graduates are based on the rates of total enrollment which have increased steadily during the last few years. Assuming that current trends in the proportion of graduates in scientific fields will continue, the recent rates of enrollment insure a continual increase in numbers of science graduates for at least several more years.

(4) Chart 4 shows the numbers of persons now employed in scientific fields who hold the Soviet Kandidat degree and the American PhD (in which the Sc. D. has been included). In terms of formal requirements, which include three or more years of post-graduate study and a thesis, the Soviet degree of Kandidat is the near equivalent of the PhD. The total number of U.S. PhD's considerably exceeds the number of Soviet Kandidates; however, 85% of the Soviet Kandidats and only one-half of the American PhD's are still in scientific [redacted]

number of Kandidats actually contributing to science and technology exceeds the total number of PhD's.

d. Reliability of data

In dealing with scientific nampower statistics where categories lack precision exactness cannot be expected. The data for both the Soviet Union and the United States are in places either estimated or incomplete. During recent years, for the Soviet Union, data became increasingly scarce, while, for the Unite States, often the reverse is true. In most comparisons, uncertainties of about ten percent are not unlikely.

The data used in the calculations for the U.S.S.R. are drawn from open Soviet literature - statistical year books (before 1940), journals and newspapers.

The following considerations support the general reliability of these data:

(1) Pre-war data are taken largely from comperatively detailed statistical compilations published for the Soviets own use in planning.

(2) Data since the war, while generally increasingly scarce, are consistent with pre-war trends.

(3) Scarcity of data itself indicates the restriction of information by withholding rather than falsification.

(4) Classified data for 1941, siezed by the Germans and later published, agreed well with the information which had appeared in open publications.

All of the Data for American graduates and holders of the Ph.D. degree were furnished by the Commission of Human Resources and Advanced Training of the National Research Council.

4. TRENDS IN THE GROWTH OF SCIENTIFIC MANPOWER

a. Indications for Continued Growth

Current rates of growth of the major components of scientific-technical manpower are greater in the Soviet Union than in the United States. This has been seen in the case of graduates of higher educational institutions in scientific fields, and in the growth in the numbers of the holders of higher degrees, nor have there yet appeared any indications that Soviet rates of growth will slacken. Present Soviet plans call for increasing numbers of graduates and higher degrees to be awarded. At least in the case of engineers, rates of growth have not kept pace with industrial expansion. The current crisis in Soviet agriculture will put increased emphasis on the training of agronomists. The programs of post-graduate training which lead to the Kandidat degree have been expanding rapidly and steadily. There is much discussion in the Soviet press about how to improve these programs and to increase the number of aspirants successfully completing them.

The levels of efficiency and productivity of the Soviet economy, rather than its size, determines its need for engineers

and scientists. Per unit of output, the Soviet economy already has far more technically trained college-level graduates than does that of the United States. Nor are the numbers of doctors per thousand of population significantly less in the Soviet Union than in the United States. In themselves, these circumstances would suggest an incipient reduction in the rates of growth of Soviet scientific-technical manpower making them more similar to those in the United States. The continued high rates of expansion of the Soviet scientific-technical manpower show that Soviet leaders believe that by such expansion, they can improve productivity. This expansion will continue as long as the current program is clearly effective and profitable.

5. TRENDS IN THE QUALITY OF SCIENTIFIC MANPOWER

a. General

The primary determinant of professional competence is the quality of professional education. Those who will graudate from Soviet higher educational institutions during the next fifteen years will be drawn from students who are now enrolled in all grades of the educational system. Consequently, the competence of future graduates will depend upon the present and continuing quality of education at all levels.

b. The educational system

The Soviet educational system comprises several major components. The primary school, lasts for four years and is normally entered at the age of seven. The addition of grades 5, 6, and 7, which are referred to as the "middle school", forms the "incomplete secondary school", or, "seven year school", and the further addition of grades 8, 9, and 10 forms the "complete secondary school", or, "ten year school".

Parallel to the system of general secondary education, there are trade and specialized schools which are attended by students who do not complete their secondary education. These include the factory apprentice schools ("FZO") and the tekhnikums. They are normally entered after 7 years of study, and the tekhnikums, which offer 3 and 4 year courses, of rather narrow specialization, produce competent technicians. Above the secondary or ten year schools and the tekhnikums stand the higher educational institutions (VUZ's) most of which have courses of around 5 years in length. They include over 30 "universities" which produce most of the Soviet Union's research scientists, and nearly 900 specialized institutions which turn out engineers, agronomists, doctors, lawyers, teachers and other types of professional persons.

The heavy stress upon science throughout the entire Soviet educational system has already been noted. It is apparently in the high percentage of graduates of higher educational institutions in scientific fields. A similar emphasis on science is found in the curricula of the secondary schools. These curricula are, to a large extent, standardized throughout the U.S.S.R. and appear to offer a good foundation for later studies in science.

Those who are now graduating from higher educational institutions number only a few percent of their first class in primary school some fifteen years ago. Limited educational facilities have not permitted all of the others to even finish their secondary education. Some have left after primary school but most after the seven year school to go to work or to enter technical secondary schools. Students whose families cannot spare their earning power or who live too far from seven or ten

year schools, as is frequent in rural areas, are unable to continue their education in these institutions. Among those who are not thus eliminated, scholastic ability is the main condition for continuing their education, although nepotism and political activeness may have some influence. Stipends and scholarships from the end of the seventh year are weighted to favor good students. Thus, only more gifted and industrious students have survived to enter higher schools. The resultant scholastic competition has been a strong factor in achieving and maintaining standards in upper secondary and higher education.

c. Conditions affecting trends in quality

Expansion of the educational system is creating both opportunities and obstacles for its qualitative improvement. Expansion of enrollment in the latter grades of secondary schools draws in some mediocre students which were formerly excluded by keener competition and may well result in some lowering of the average quality of ten year school graduates from which the higher educational institutions must draw their students. On the other hand, if as is morelikely, the screening to select the most capable and promising students for training in science and engineering in institutions of higher education continues in the future, more excellent students will become available for higher educational institutions.

The Soviets are well aware of the issues facing the educational system and are devoting a great deal of attention to the problems of improving educational standards, and are certain to continue to press

for qualitative improvements. Scientists, engineers and teachers of all levels are engaged in determining what improvements are needed and how to achieve them. The Soviet press is full of their discussions and arguments. And there is relatively little occasion for ideological issues to inhibit debate. The questions argued include the qualifications of teachers, the desirable degree of specialization, the proper balance between theoretical and practical, and laboratory work, and the academic and extra-curricular programs which the student can profitably carry. There is little reason to suppose that such investigations will fail to find better and better measures for maintaining the standards of middle and higher education. With the official support which they have, these investigations indicate a probable continued rise in the quality of the Soviet scientific-professional class.

h. Conclusion

Despite the obvious uncertainties that attend predictions, consistent emphasis by the U.S.S.R. during recent years on scientific and technical training, and the reliable information regarding its attainments thus far, leaves no good reason for assuming that the U.S.S.R. will not continue to improve its position vis-a-vis the U.S. during the next 10-15 years.

This trend toward an unfavorable balance could be altered by a major increase in emphasis on scientific and technical training in the U.S. or by radical de-emphasis in the U.S.S.R. No basis for either

assumption has been found, however, and in their absence, the following conclusions have been derived:

(1) Despite some differences, the general composition of Soviet scientific-technical manpower - i.e. the relative numbers of graduates and holders of higher degrees and the relative numbers of these persons in the physical, agricultural and health sciences - is basically similar to that of the United States.

(2) The present quality of Soviet scientific-technical manpower is comparable with that of the United States.

(3) If present trends continue the number and total capabilities of the Soviet scientific and engineering manpower will exceed that of the United States within the near future.